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(54) THERMOSETTING ACRYLIC POWDER COATING COMPOSITIONS

(71) We, KANSAI PAINT COMPANY LIMITED, of No. 365, Kanzaki, Amagasaki-shi, Hyogo-ken, Japan, a Japanese Body Corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a thermosetting acrylic powder coating composition, more particularly to a thermosetting acrylic powder coating composition containing a specific thermosetting acrylic resin and curing agent.

In recent years powder coating composition has gained growing interest and introduced into practical application. For example, powder coating compositions of epoxy resin or polyvinyl chloride are known in the art. However, the former is poor in weather resistance and is therefore unfit for outdoor use, while the latter is low in adhesiveness to metallic substance, which necessitates the use of primer and renders it difficult to produce thin coating film.

On the other hand, thermosetting acrylic resin has been extensively used as a solvent-type paint to give a coating film having a bright color, excellent weather resistance, excellent color retention and excellent chemical resistance due to the characteristics of the resin. Utilizing the above characteristics of the acrylic resin many attempts have been made to produce thermosetting acrylic powder coating compositions, but no useful powder coating composition has been proposed yet. For example, it is known in the art to use an acrylic resin modified with epoxy resin or an acrylic resin having hydroxyl groups modified with melamine resin. However, according to the former resin not only the epoxy resin used is restricted to a specific kind of solid resin but also it is required to use a large amount of epoxy resin, impairing the aforementioned excellent characteristics of acrylic resin. Further, according to the latter resin blistering of the coating film occurs during baking step thereof due to the alcohol produced in the course of cross-linking reaction, this failing to produce a film having smooth surface.

The thermosetting acrylic powder coating composition of the present invention comprises an acrylic resin having glycidyl groups in the molecule and having a glass transition temperature of 40 to 70°C and an aliphatic dibasic acid, anhydride thereof, substances producing said dibasic acid under a curing condition or mixtures thereof; said acrylic resin being a copolymer of

1) 70 to 95 weight percent of a) at least one alkyl ester of acrylic acid or methacrylic acid represented by the formula of

$$CH_2=\underset{\substack{|\\ R^1}}{C}-COOR^2 \qquad \text{(I)}$$

in which R^1 is hydrogen atom or methyl group and R^2 is an alkyl group having 1 to 17 carbon atoms or b) a 1:up to 1.5 weight ratio mixture of said alkyl esters and other vinyl monomers and

2) 5 to 30 weight percent of glycidyl acrylate, glycidyl methacrylate or mixtures thereof; and said aliphatic dibasic acid having the formula of

$$HOOC-R-COOH \qquad \text{(II)}$$

in which R is a saturated or unsaturated aliphatic hydrocarbon group having 4 to 11 carbon atoms.

According to the researches of the present inventor it has been found that when said

[*Price 25p*]

acrylic resin having glycidyl groups is used in combination with a specific curing agent, aliphatic dibasic acid and/or anhydride thereof, it is possible to obtain coating film which retains excellent characteristics inherent to acrylic resin. In fact, the coating film obtained from the present powder coating composition is bright in color, smooth in surface and non-yellowing and displays excellent weather resistance, excellent color retention, excellent chemical resistance, excellent water resistance and excellent humidity resistance which are rather superior to those of the coating film obtained from the conventional solvent-type paint of acrylic resin. Further, the present powder coating composition can be applied to various articles including metallic articles to produce a coating film strongly adhered to the articles without using any primer. According to the present powder coating composition, moreover, a coating film having a desired thickness can be obtained whether thick or thin free from blistering. For example, not only a thin film of about 30 μ is obtainable but also a thick film of about 200 μ can easily be produced without any formation of blistering. Further the coating obtained from the present powder coating composition is hard and excellent in abrasion resistance, flexibility and stain resistance. Further, the acrylic resin used in the present invention has a high glass transition temperature of 40 to 70° C, so that undesired caking never occurs even when the storage temperature rises.

The acrylic resin having glycidyl groups used in the invention has a glass transition temperature of 40 to 70°C. When the glass transition temperature of the resin is lower than 40°C undesired caking occurs during storage due to the rise of the temperature, while the resin having a glass transition temperature of higher than 70°C fails to produce a smooth-surfaced coating film. Preferable glass transition temperature of the resin is in the range of 45 to 55°C. The acrylic resin is a copolymer containing 5 to 30 weight percent of glycidyl acrylate and/or glycidyl methacrylate. The other monomer is (a) an alkyl ester of acrylic acid or methacrylic acid represented by the formula (I) or (b) a 1 : up to 1.5 weight ratio mixture of said alkyl esters of the formula (I) and other vinyl monomers. The monomer (a) or (b) is contained in the copolymer in the range of 70 to 95 weight percent. When the copolymer contains less than 5 weight percent of glycidyl esters it results in the production of a coating film inferior in solvent resistance and flexibility, while if the content of glycidyl esters is more than 30 weight percent the specular gloss of the resultant coating film is markedly impaired. The copolymer preferably comprises 10 to 20 weight percent of glycidyl esters and 80 to 90 weight percent of the other monomer (a) or (b). Of these copolymers those comprising glycidyl ester and the monomer (a) represented by the formula (I) are preferable.

Preferable examples of the monomer (a), i.e., alkyl esters of acrylic acid or methacrylic acid having the formula (I) above are methyl acrylate, methyl methacrylate, butyl acrylate, butyl methacrylate, 2-ethylhexyl acrylate, 2-ethylhexyl methacrylate, octyl acrylate, octyl methacrylate, lauryl methacrylate, dimethylaminomethyl acrylate, dimethylaminoethyl methacrylate, diethylaminoethyl acrylate and diethylaminoethyl acrylate and diethylaminoethyl methacrylate. The copolymer of glycidyl esters and monomer (b), i.e., the mixture of alkyl esters of the formula (I) and other vinyl monomers can be used in the invention. Such vinyl monomers are, for example, styrene, acrylonitrile, vinyl acetate and vinyl toluene. The mixture ratio in weight of alkyl esters of the formula (I) and the vinyl monomer is 1 : up to 1.5, preferably 1 : up to 1. The coploymer used in the invention can be prepared by various known methods, for example, by suspension polymerization, which are conventional to the polymerization of vinyl monomers.

It is essential in the invention to use as a curing agent aliphatic dibasic acids having the formula (II) above and anhydrides thereof. Other curing agents such as aliphatic amines, aromatic amines, modified amines and aromatic polybasic acids, cannot be used in the invention, since curing reaction occurs during storage or when it is kneaded with the acrylic resin having glycidyl groups at a room temperature or elevated temperature. The aliphatic dibasic acids and anhydrides thereof used in the invention can be homogeneously mixed with the acrylic resin having glycidyl groups in molten state without any undesired curing reaction. The aliphatic dibasic acids include not only saturated dibasic acids but also unsaturated dibasic acids. Preferable examples of the saturated aliphatic dibasic acids are adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid and undecane-1,11-dicarboxylic acid. Preferable unsaturated aliphatic dibasic acids are, for example, dihydromuconic acid and muconic acid. Anhydrides of these acids can also be used in the invention. Examples thereof are adipic anhydride, azelaic anhydride and sebacic anhydride. In the invention there can be used as a curing agent a substance capable of producing the above dibasic acid under curing conditions. Examples of such substances are polysebacic polyanhydride and polyazelaic polyanhydride which are derived from intermolecular condensation of sebacic acid or azelaic acid.

The amount of the curing agent, aliphatic dibasic acids and anhydrides thereof, used relative to the acrylic resin having glycidyl

groups may vary over a wide range in accordance with the number of glycidyl groups contained in the acryl resin. Usually it is preferable to employ such curing agent in the range of 0.5 to 2.0 equivalent in terms of the carboxyl group contained therein per one equivalent of the glycidyl group contained in the acrylic resin. The most preferable amount thereof is in the range of 0.7 to 1.2 equivalent to the glycidyl group.

In preparing the powder coating composition of the present invention it is preferable to blend the acrylic resin having glycidyl groups with curing agent in a molten state at a temperature of lower than about 150°C, preferably 80 to 130°C, and solidify the blended material by cooling, followed by pulverization into fine powder having usually about 20 to about 150 μ of particle size. As mentioned before, no curing reaction occurs during the blending step in a molten state at a temperature of lower than about 150°C, so that homogeneous composition can be obtained. If desired, pigments, fillers, and/or leveling agents can be added to the composition. In such a case these additives are added to the composition before or during the blending step. The blender used may be conventional one, such as heating roll, heating kneader, extruder etc. It is also possible to mix the resin and curing agent in the form of powder, but this process is not preferable because the particle sizes of the both substances are considerably different and adjustment thereof is difficult.

Excellent coating film can be obtained from the present powder coating composition, as disclosed before, so that the composition can be extensively used in various fields. For example, it is particularly suitable for coating automobiles, steel furniture, etc., in which beautiful appearance and durability are required. Further, it is also suitable for coating outdoor fences which must be highly resistant to weather.

The present composition can be applied to articles to be coated by the known methods conventional to the powder coating. The baking is conducted at a temperature of higher than 150°C, preferably 180 to 220°C to effect the curing reaction.

For a better understanding of the invention examples are given below, in which all parts and percentages are by weight unless otherwise specified.

Example 1.

In a flask were placed 200 parts of water, 50 ppm of sodium lauryl sulfate, 1500 ppm of sodium sulfate and 200 ppm of polyvinyl alcohol and the mixture (referred to hereinafter and in subsequent Examples as the starting mixture) was heated to 80°C. To the starting mixture were added with stirring 28 parts of methyl methacrylate, 11 parts of butyl acrylate, 13 parts of glycidyl methacrylate, 38 parts of styrene, 10 parts of ethyl acrylate, 1.0 part of azobisisobutylonitrile and 200 ppm of stearic acid. The resultant mixture was heated with stirring at 80°C for 4 hours for suspension polymerization, whereby a granular copolymer having a glass transition temperature of 43°C was obtained.

100 parts of the resultant copolymer was mixed at room temperature for 10 minutes with 6.7 parts of adipic acid, 30 parts of titanium dioxide and 1 part of "Modaflow" (Trade Mark, leveling agent made by Monsanto Co., U.S.A.). The resultant mixture was then kneaded under molten state by a heating roll at 105°C for 15 minutes and after being cooled the kneaded mixture was pulverized into particles of 20 to 150 μ to produce a powder coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant composition by electrostatic powder coating and the coating was baked at 200°C for 15 minutes. The physical properties of the coating film are shown in the appended Table I.

For comparison, in preparing powder coating composition in the same manner as above, 5.4 parts of succinic acid, 4.75 parts of maleic acid, and 6.7 parts of phthalic anhydride were respectively used as a curing agent in the place of 6.7 parts of adipic acid. However, respective mixtures underwent gelation during the kneading step, failing to produce powder coating compositions.

Example 2.

100 parts of the copolymer obtained in the same manner as in Example 1 was mixed at room temperature for 10 minutes with 9.2 parts of sebacic acid, 10 parts of iron oxide, 20 parts of titanium dioxide and 0.8 part of "Modaflow" (Trade Mark, the same as in Example 1). The resultant mixture was then kneaded under molten state by an extruder at 100°C for 3 minutes and after being cooled the kneaded mixture was pulverized into particles of 20 to 150 μ to produce a powder coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant powder coating composition by electrostatic powder coating and the coating film was baked at 200°C for 15 minutes. The physical properties of the coating film are shown in the appended Table 1.

Example 3.

To the starting mixture obtained from the same ingredients as in Example 1 was added a mixture of 65 parts of methyl methacrylate, 22 parts of butyl acrylate, 13 parts of glycidyl methacrylate, 1.0 part of azobisisobutylonitrile and 200 ppm of stearic acid and the resultant mixture was heated at 80°C for 5 hours for suspension polymerization, whereby a copoly-

mer having a glass transition temperature of 49°C was obtained.

100 parts of the resultant copolymer was mixed at room temperature for 10 minutes with 6.7 parts of adipic acid, 30 parts of titanium dioxide and 1 part of "Modaflow" (Trade Mark, the same as in Example 1). The resultant mixture was then kneaded under molten state by an extruder at 105°C for 3 minutes and after being cooled the kneaded mixture was pulverized into particles of 20 to 150 μ to produce a powder coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant composition by electrostatic powder coating and the coating was baked at 200°C for 15 minutes. The physical properties of the coating film are shown in the appended Table 1.

Example 4.

To the starting mixture obtained from the same ingredients as in Example 1 was added a mixture of 26 parts of methyl methacrylate, 19 parts of butyl acrylate, 15 parts of glycidyl methacrylate, 35 parts of styrene, 5 parts of ethyl acrylate, 1.0 part of azobisisobutylonitrile and 200 ppm of stearic acid and the resultant mixture was heated at 70°C for 4 hours for suspension polymerization, whereby a copolymer having a glass transition temperature of 45°C was obtained.

100 parts of the resultant copolymer was mixed at room temperature for 10 minutes with 8.6 parts of azelaic acid, 30 parts of titanium dioxide and 1 part of "Modaflow" (Trade Mark, the same as in Example 1). The resultant mixture was then kneaded under molten state by a heating roll at 100°C for 15 minutes and after being cooled the kneaded mixture was pulverized into particles of 20 to 150 μ to produce a powder coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant composition by electrostatic powder coating and the coating was baked at 200°C for 15 minutes. The physical properties of the coating film are shown in the appended Table 1.

Example 5.

To the starting mixture obtained from the same ingredients as in Example 1 was added a mixture of 24 parts of methyl methacrylate, 11 parts of butyl acrylate, 17 parts of glycidyl methacrylate, 38 parts of styrene, 10 parts of ethyl acrylate, 1.0 part of azobisisobutylonitrile and 200 ppm of stearic acid and the resultant mixture was heated at 80°C for 5 hours for suspension polymerization, whereby a copolymer having a glass transition temperature of 55°C was obtained.

100 parts of the resultant copolymer was mixed at room temperature for 10 minutes with 8.0 parts of sebacic acid, 30 parts of titanium dioxide and 1 part of "Modaflow" (Trade Mark, the same as in Example 1). The resultant mixture was then kneaded under molten state by a heating roll at 105°C for 15 minutes and after being cooled the kneaded mixture was pulverized into particles of 20 to 150 μ to produce a powder coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant composition by electrostatic powder coating and the coating was baked at 220°C for 12 minutes. The physical properties of the coating film are shown in the appended Table 1.

Example 6.

In the same manner as in Example 5, the powder coating composition was obtained from 100 parts of the copolymer prepared in the same manner as in Example 5, 12.1 parts of sebacic acid, 30 parts of titanium dioxide and 1 part of "Modaflow" (Trade Mark, the same as in Example 1).

The composition thus obtained was applied to a steel plate pretreated with zinc phosphate and baked in the same manner as in Example 5. The physical properties of the resultant coating film are shown in Table 1.

Example 7.

In the same manner as in Example 5, the powder coating composition was obtained from 100 parts of the copolymer prepared in the same manner as in Example 5, 18.1 parts of sebacic acid, 30 parts of titanium dioxide and 1 part of "Modaflow" (Trade Mark, the same as in Example 1).

The composition thus obtained was applied to a steel plate pretreated with zinc phosphate and baked in the same manner as in Example 5. The physical properties of the resultant coating film are shown in Table 1.

Example 8.

To the starting mixture obtained from the same ingredients as in Example 1 was added a mixture of 28 parts of methyl methacrylate, 11 parts of butyl acrylate, 10 parts of glycidyl methacrylate, 38 parts of styrene, 13 parts of ethyl acrylate, 1.0 part of azobisisobutylonitrile and 200 ppm of stearic acid and the resultant mixture was heated at 80°C for 4 hours for suspension polymerization, whereby a copolymer having a glass transition temperature of 51°C was obtained.

100 parts of the resultant copolymer was mixed at room temperature for 10 minutes with 7.1 parts of sebacic acid, 5 parts of carbon black and 1 part of "Modaflow" (Trade Mark, the same as in Example 1). The resultant mixture was then kneaded under molten state by an extruder at 100°C for 4 minutes and after being cooled the kneaded mixture was pulverized into particles of 25 to 150 μ to produce a powder coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant composition by electrostatic powder coating and the coating was baked at 200°C for 15 minutes. The physical properties of the coating film are shown in the appended Table 1.

Example 9.

To the starting mixture obtained from the same ingredients as in Example 1, was added a mixture of 19 parts of methyl methacrylate, 21 parts of butyl acrylate, 25 parts of glycidyl methacrylate, 35 parts of styrene, 1.0 part of azobisisobutylonitrile and 200 ppm of stearic acid and the resultant mixture was heated at 75°C for 5 hours for suspension polymerization, whereby a glass transition temperature of 47°C was obtained.

100 parts of the resultant copolymer was mixed at room temperature for 10 minutes with 17.8 parts of sebacic acid, 5 parts of carbon black and 1 part of "Modaflow" (Trade Mark, the same as in Example 1). The resultant mixture was then kneaded under molten state by an extruder at 100°C for 4 minutes and after being cooled the kneaded mixture was pulverized into particles of 20 to 150 μ to produce a powder coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant composition by electrostatic powder coating and the coating was baked at 200°C for 15 minutes. The physical properties of the coating film are shown in the appended Table 1.

Comparative Example 1.

To the starting mixture obtained from the same ingredients as in Example 1, was added a mixture of 35 parts of methyl methacrylate, 11 parts of butyl acrylate, 3 parts of glycidyl methacrylate, 38 parts of styrene, 13 parts of ethyl acrylate, 1.0 part of azobisisobutylonitrile and 200 ppm of stearic acid and the resultant mixture was heated at 80°C for 5 hours for suspension polymerization, whereby a copolymer having a glass transition temperature of 53°C was obtained.

100 parts of the resultant copolymer was mixed at room temperature for 10 minutes with 2.1 parts of sebacic acid, 5 parts of carbon black and 1 part of "Modaflow" (Trade Mark, the same as in Example 1). The resultant mixture was then kneaded under molten state by an extruder at 100°C for 4 minutes and after being cooled the kneaded mixture was pulverized into particles of 20 to 150 μ to produce a power coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant composition by electrostatic powder coating and the coating was baked at 200°C for 15 minutes. The physical properties of the coating film are shown in the appended Table 1.

Comparative Example 2.

To the starting mixture obtained from the same ingredients as in Example 1, was added a mixture of 19 parts of methyl methacrylate, 21 parts of butyl acrylate, 35 parts of glycidyl methacrylate, 25 parts of styrene, 1.0 part of azobisisobutylonitrile and 200 ppm of stearic acid and the resultant mixture was heated at 70°C for 4 hours for suspension polymerization, whereby a copolymer having a glass transition temperature of 45°C was obtained.

100 parts of the resultant copolymer was mixed at room temperature for 10 minutes with 24.8 parts of sebacic acid, 5 parts of carbon black and 1 part of "Modaflow" (Trade Mark, the same as in Example 1). The resultant mixture was then kneaded under molten state by an extruder at 100°C for 4 minutes and after being cooled the kneaded mixture was pulverized into particles of 20 to 150 μ to produce a powder coating composition.

Steel plate pretreated with zinc phosphate was coated with the resultant composition by electrostatic powder coating and the coating was baked at 200°C for 15 minutes. The physical properties of the coating film are shown in the appended Table 1.

TABLE 1

Properties	Test Methods	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Comp. 1	Comp. 2
Thickness of film (μ)	Electromagnetic thickness Meter	60	70	65	60	70	65	70	65	65	75	70
Specular Gloss	ASTM D-523-67	90	93	89	92	91	91	90	94	85	96	68
Hardness	Pencil Hardness	H	H	H	H	HB	H	H	HB	2H	F	2H
Impact Resistance (cm)	duPont's Impact Tester (½", 500 g)	20	30	20	30	20	40	40	20	40	<10	40
Adhesion	ASTM D-2197-68	Good	Good	Good	Good	Good	Good	Good	Good	Good	Inferior	Good
Water Resistance *1	ASTM D-870-54 (240 hours)	—	—	—	—	—	—	—	—	—	—	—
Solvent Resistance	*2	Good	Good	Good	Good	Good	Good	Good	Good	Good	Inferior	Good
Humidity Resistance *3	ASTM D-2247-68 (50°C, 240 hours)	—	—	—	—	—	—	—	—	—	+ (6MD)	—

Note: *1 In water resistance the criteria show the following test results.
—: No blistering observed
+: Blistering observed
*2 Solvent resistance.
The coating film was rubbed 100 times with gauze impregnated with xylene and surface condition of the film was inspected.
*3 In humidity resistance the criteria show the following test results.
—: No blistering observed
+: Blistering observed

Example 10.

Powder coating composition was prepared in the same manner as in Example 5, except that 13.7 g of "PSPA" (Trade Mark, poly-sebacic polyanhydride of Anhydrides And Chemicals Incorporated, U.S.A.) was used in the place of sebacic acid.

The composition was applied to a steel plate pretreated with zinc phosphate and baked in the same manner as in Example 5. The physical properties of the resultant coating film are shown in Table 2 below.

TABLE 2.

Thickness (μ)	75
Specular gloss	92
Hardness	HB
Impact resistance (cm)	40
Adhesion	Good

WHAT WE CLAIM IS:—

1. A thermosetting acrylic powder coating composition which comprises an acrylic resin having glycidyl groups in the molecule and a glass transition temperature of 40 to 70°C and an aliphatic dibasic acid, anhydride thereof, a substance producing said dibasic acid under a curing condition or mixtures thereof; said acrylic resin being a copolymer of

1) 70 to 95 weight percent of (a) at least one alkyl ester of acrylic acid or methacrylic acid represented by the formula

$$CH_2=\underset{\displaystyle R^1}{\underset{|}{C}}-COOR^2$$

in which R^1 is hydrogen atom or methyl group and R^2 is an alkyl group having 1 to 17 carbon atoms or (b) a 1 : up to 1.5 weight ratio mixture of said alkyl esters and other vinyl monomers and

2) 5 to 30 weight percent of glycidyl acrylate, glycidyl methacrylate or mixtures thereof; and said aliphatic dibasic acid having the formula

$$HOOC—R—COOH$$

in which R is a saturated or unsaturated aliphatic hydrocarbon group having 4 to 11 carbon atoms.

2. A thermosetting acrylic powder coating composition according to Claim 1, in which said acrylic resin has a glass transition temperature of 45 to 55°C.

3. A thermosetting acrylic powder coating composition according to Claim 1 or Claim 2, in which said copolymer contains 10 to 20 weight percent of glycidyl acrylate or glycidyl methacrylate.

4. A thermosetting acrylic powder coating composition according to Claim 1 or Claim 2, in which said copolymer comprises 70 to 95 weight percent of at least one of said alkyl esters and 5 to 30 weight percent of said glycidyl ester or esters.

5. A thermosetting acrylic powder coating composition according to Claim 1 or Claim 2, in which said copolymer comprises 70 to 95 weight percent of a 1 : up to 1.5 weight ratio mixture of said alkyl esters and other vinyl monomers and 5 to 30 weight percent of said glycidyl ester or esters.

6. A thermosetting acrylic powder coating composition according to Claim 5, in which said vinyl monomer is styrene, acrylonitrile, vinyl acetate or vinyl toluene.

7. A thermosetting acrylic powder coating composition according to Claim 5 or Claim 6, in which said mixture ratio of said alkyl esters and vinyl monomer is 1 : up to 1.

8. A thermosetting acrylic powder coating composition according to any preceding claim, in which said aliphatic dibasic acid is a saturated aliphatic dibasic acid having said formula in which R is a saturated hydrocarbon group having 4 to 11 carbon atoms.

9. A thermosetting acrylic powder coating composition according to Claim 8, in which said saturated aliphatic dibasic acid is adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic or undecane-1, 11-dicarboxylic acid.

10. A thermosetting acrylic powder coating composition according to any preceding Claim, in which said aliphatic dibasic acid is an unsaturated aliphatic dibasic acid having said formula in which R is an unsaturated aliphatic hydrocarbon group having 4 to 11 carbon atoms.

11. A thermosetting acrylic powder coating composition according to Claim 10, in which said unsaturated aliphatic dibasic acid is dihydromuconic acid or muconic acid.

12. A thermosetting acrylic powder coating composition according to any preceding claim, in which said aliphatic dibasic acid anhydride is adipic anhydride, azelaic anhydride or sebacic anhydride.

13. A thermosetting acrylic powder coating compostiion as claimed in Claim 1 and substantially as described herein with reference to any one of the foregoing Examples.

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